MULTI-COMPONENT NONWOVEN FABRIC FOR USE IN DISPOSABLE ABSORBENT ARTICLES

Technical Field

The present invention relates generally to nonwoven fabrics, and more particularly to a nonwoven fabric which can be configured to include multiple components which are integrated to facilitate liquid-acceptance, liquid-distribution, and liquid-retention, thus facilitating use of the fabric in disposable absorbent articles, such as disposable diapers and feminine hygiene products.

Background Of The Invention

Disposable absorbent products such as disposable diapers, feminine protection products, incontinence products, and similar articles have met with very widespread acceptance in the marketplace. These types of products have significantly supplanted other types of absorbent articles, such as woven cloth materials, in products such as described above. Development of nonwoven fabric materials, as well as absorbent materials including wood pulp fluff and superabsorbent polymers (SAP) have permitted disposable absorbent products to provide very high levels of absorption and containment, as well as economical and comfortable use by consumers.

A typical disposable absorbent product includes a quantity of absorbent material, ordinarily comprising cellulosic fibrous material such as wood pulp fibers. The use of superabsorbent polymers, ordinarily in particulate form, has been found to desirably enhance liquid-retention. Aside from absorbent material, a typical disposable absorbent article includes an outer, substantially liquid-impermeable layer, and an inner, substantially liquid-permeable layer through which liquids are introduced into the absorbent material. The outer, liquid-impermeable layer acts to contain the liquid within the absorbent structure.

Various attempts have been made to enhance liquid-acceptance and liquid-retention characteristics of disposable absorbent articles. In order to promote liquid-acceptance, a wide variety of different materials have been used for the inner, liquid-permeable layer (sometimes referred to as the "facing" or

"top-sheet") of such articles to promote passage of liquid through this layer to the absorbent structure, while avoiding wetting of the layer itself which can detract from comfortable use by consumers. A number of previous constructions have attempted to enhance liquid-retention in disposable absorbent articles by maximizing efficient use of the absorbent structure. Since such absorbent structures may not exhibit a tendency to wick liquid throughout the structure from a point of introduction, so-called liquid-transfer or liquid-distribution layers have been incorporated into absorbent articles to promote use of all portions of the absorbent structure.

As will be appreciated from the above discussion, typical absorbent disposable products include a number of distinct components to achieve fluid management, but efficient manufacture of such products is complicated as the number of distinct components increases. These types of products are typically fabricated from webs of the various constituent layers, with high-speed manufacture requiring efficient handling, registration, and cutting of such webs. It is ordinarily necessary to replenish the supply of each of the constituent webs during manufacture, with an increase in the number of constituent layers requiring a like increase in the periodic replacement of the rolls on which the webs of material are typically stored. Web replenishment can be labor intensive since the rolls themselves may be relatively large and bulky, with each new roll requiring splicing into the end of the previous web. While absorbent structures in such articles may be provided in web-like form, such structures are frequently individually formed from comminuted wood pulp, by air-laying, with the absorbent structures individually cut from a vacuum-formed batt, or individually formed by use of a pocket-forming vacuum apparatus. Again, juxtaposition and registration of each of the absorbent structures with the associated webs of facing and backing materials complicates high-speed manufacture of disposable absorbent articles. Additionally, air-laid absorbent structures typically exhibit very little structural integrity, further complicating high-speed handling after formation.

In view of the foregoing, efforts have been made to provide nonwoven materials, which integrate two or more of the typical layers or components provided in a disposable absorbent structure. However, such efforts have met with only limited success, since integration of the materials from which the various layers are formed can be difficult to effect in an efficient fashion. Additionally, integrated arrangements may diminish effectiveness of one or more of the constituent layers, thus detracting from the efficacy of the resultant absorbent product.

Accordingly, the present invention contemplates a multi-component nonwoven material that acts to efficiently integrate plural components of a disposable absorbent article, thus promoting efficient manufacture, while obtaining the desired level of product performance. A further aspect of the present invention contemplates formation of absorbent structures exhibiting desirably high performance and structural integrity.

Summary Of The Invention

A multi-component nonwoven fabric embodying the principles of the present invention is particularly suited for use in disposable absorbent articles, and is intended to promote efficient fluid management in such articles, while facilitating economical, high-speed manufacture by reduction in the number of separate components in each article. The fabric is formed with an array of three-dimensional surface projections that minimize contact with a wearer to promote comfort, with the projections further promoting enhanced fluid management. The fabric may optionally be provided with a network of apertures, which are configured to cooperate with the surface projections for control of liquid flow. The fabric includes fibers having liquid acceptance and liquid distribution performance integrated into the layers to promote efficient fluid management, with the fabric optionally including an additional liquid-retention layer. Said aforementioned fibers are provided in layers during nonwoven fabric formation. A further aspect of the present invention contemplates formation of a multi-component nonwoven fabric, by hydroentanglement, which exhibits very high

structural integrity without the application of adhesive binder, while providing excellent absorbent capacity.

In accordance with the illustrated embodiment, the present three-dimensional, multi-component nonwoven fabric includes two or more "layers" for receiving, distributing and possibly retaining liquids introduced into the article. These layers may comprise thermoplastic fibers preferentially selected from the group consisting of polyolefins, polyesters, polyamides, and blends thereof, bi-component, splittable thermoplastic fibers of the pie or side-by-side variety, cellulosic fibers such as rayon, wood pulp and blends thereof, and surface profiled fibers such as 4DG. Heat fusible fibers may be introduced into any of the layers to stabilize the structure and enhance the retention of the three-dimensional surface projections of the fabric.

The use of hydroentanglement to effect formation of the present nonwoven fabric permits the fabric to be formed with certain structural features for enhancing versatile use. If desired, a lower layer can be configured to extend into the array of three-dimensional surface projections defined by the upper surface of the fabric. The fabric can be formed with a plurality of apertures that extend from the upper surface through at least a portion of the nonwoven fabric. In a particularly preferred embodiment, the apertures extend from the network of liquid-accepting channels that surround the upstanding projections defined by the upper surface. This arrangement desirably functions such that liquid is channeled and directed by the upstanding projections for passage through the network of apertures defined by the fabric.

As will be appreciated, integration of the desired liquid-acceptance and liquid-distribution properties into one fabric promotes use of the present nonwoven fabric and disposable absorbent article by precluding the need to provide these layers as separate components during product manufacture. A further aspect of the present invention contemplates that the present multi-component fabric includes a lower liquid-retention layer. The liquid retention layer preferably at least partially comprises cellulosic fibers selected from the group consisting of wood pulp fibers and rayon fibers. More preferably, the

liquid-retention layer comprises a blend of cellulosic fibers, and thermoplastic fibers having a denier of about 6 and 18, preferentially selected from the group consisting of polyolefins, polyesters, polyamides, and blends thereof. The absorptive capacity of the liquid-retention layer can be enhanced by the provision of superabsorbent polymer within the fibrous structure of the layer.

Absorbent materials formed in accordance with the present invention exhibit desirably high absorbency relative to the thickness of the material, thus permitting disposable products to exhibit the desired degree of absorbency without excessive bulkiness.

Other features and advantages of the present invention will become readily apparent from the following detailed description, the accompanying drawings, and the appended claims.

Brief Description Of The Drawings

FIGURE 1 is a schematic representation of a production line upon which the process of the present invention is practiced, and the fabric of the present invention is produced;

FIGURES 2A-2C, and FIGURES 3A-3C are diagrammatic plan views of the forming surface of a three-dimensional image transfer device which is used, during hydroentanglement, to practice the present invention; and

FIGURE 4 are illustrations of various three-dimensional image profiles of surface projections of a liquid-acceptance layer of a multi-component nonwoven fabric embodying the principles of the present invention; and

FIGURE 5 are illustrations of various cross-sectional configurations of a nonwoven fabric embodying the principles of the present invention; and

FIGURE 6 is the schematic representation of the nonwoven fabrics of Examples 1 and 2; and

FIGURE 7 is the schematic representation of the nonwoven fabrics of Examples 3 and 4; and

FIGURE 8 is the schematic representation of the nonwoven fabric of Example 5; and

FIGURE 9 is the schematic representation of the nonwoven fabric of Example 6; and

FIGURE 10 is the schematic representation of the nonwoven fabric of Example 8; and

FIGURE 11 is the schematic representation of the nonwoven fabric of Example 10.

Detailed Description

While the present invention is susceptible of embodiment in various forms, there is shown in the drawings, and will hereinafter be described, presently preferred embodiments, with the understanding that the present disclosure is to be considered as an exemplification of the invention, and is not intended to limit the invention to the specific embodiments illustrated.

The present invention contemplates a multi-component nonwoven fabric that is particularly suited for use in disposable absorbent products, such as disposable diapers, sanitary napkins, incontinence products, and the like. In its multi-component form, the present nonwoven fabric facilitates efficient fluid management in such disposable products, effectively accepting, distributing, and retaining liquid. Formation through hydroentanglement of the multi-component fabric as an integrated structure facilitates its efficient use in high-speed manufacture of disposable absorbent products, since the present fabric can be used in roll form in converting applications. Fabric imaging and patterning, achieved through hydroentanglement on three-dimensional image transfer devices, permits the fabric to be formed with structural features which promote efficient fluid management and wearer comfort. By hydroentanglement of a fibrous structure, including cellulosic fibers such as wood pulp fluff and/or rayon, an absorbent structure can be formed which exhibits a desirably high degree of structural integrity, as well as high absorbent capacity relative to the thickness of the structure.

With particular reference to FIGURE 1, therein is illustrated an apparatus for practicing the method of the present invention for forming a nonwoven fabric. The fabric is formed from a fibrous matrix, which comprises fibers

selected to promote economical manufacture, while achieving the desired fluid management capabilities for the resultant fabric. The fibrous matrix is preferably carded and subsequently aid-randomized to form a precursor web, designated P.

FIGURE 1 illustrates a hydroentangling apparatus for forming nonwoven fabrics in accordance with the present invention. The apparatus includes a foraminous forming surface in the form of a flat bed entangler 12 upon which the precursor web P is positioned for pre-entangling. Precursor web P is then sequentially passed under entangling manifolds 14, whereby the precursor web is subjected to high-pressure water jets 16. This process is well known to those skilled in the art and is generally taught by U.S. Patent No. 3,485,706, to Evans, hereby incorporated by reference.

The entangling apparatus of FIGURE 1 further includes an imaging and patterning drum 18 comprising a three-dimensional image transfer device for effecting imaging and patterning of the now-entangled precursor web. After pre-entangling, the precursor web is trained over a guide roller 20 and directed to the image transfer device 18, where a three-dimensional image is imparted into the fabric on the foraminous forming surface of the device. The web of fibers is juxtaposed to the image transfer device 18, and high pressure water from manifolds 22 is directed against the outwardly facing surface from jet spaced radially outwardly of the image transfer device 18. The image transfer device 18, and manifolds 22, may be formed and operated in accordance with the teachings of commonly assigned U.S. Patents No. 5,098,764, No. 5,244,711, No. 5,822,823, and No. 5,827,597, the disclosures of which are hereby incorporated by reference. It is presently preferred that the precursor web P be given a three-dimensional image suitable to provide fluid management, as will be further described, to promote use of the present nonwoven fabric in disposable absorbent articles. The entangled fabric can be vacuum dewatered at 24, and dried at an elevated temperature on drying cans 26.

The formation of a multi-component nonwoven fabric embodying the principles of the present invention is effected by forming the precursor fibrous

web P to include a first fibrous layer comprising thermoplastic fibers preferentially selected from the group consisting of polyolefins, polyesters, polyamides, and blends thereof; splittable thermoplastic fibers of the pie type; or cellulosic fibers preferentially selected from the group consisting of wood pulp, rayon and blends thereof.

The precursor web further includes a second fibrous layer comprising at least one of the following or a blend thereof; thermoplastic fibers having a denier of about 6 to 18, preferentially selected from the group consisting of polyolefins, polyesters, polyamides, and blends thereof; heat-fusible fibers; profiled thermoplastic fibers; or cellulosic fibers.

Formation of the precursor web P with first and second fibrous layers as described above promotes formation of a multi-component nonwoven fabric having cooperating liquid-acceptance and liquid-distribution layers. It is within the purview of the present invention that a multi-component nonwoven fabric can be formed with a third, liquid-retention layer. To this end, the precursor web P can be formed with a third fibrous layer at least partially comprising cellulosic fibers selected from the group consisting of wood pulp fibers, rayon fibers, and blends thereof. The second fibrous layer of the precursor web is positioned between the first and third fibrous layers for formation of such a three-component fabric.

Formation of the present fabric is effected by positioning the precursor web P on the image transfer device 18 with the first fibrous layer of the precursor web positioned adjacent to the foraminous forming surface of the image transfer device. The forming surface of the image transfer device defines an array of surface depressions by which an array of three-dimensional upstanding surface projections is formed on the fabric. The array of upstanding projections defined by the surface of the fabric extends above a network of liquid-accepting channels surrounding the upstanding projections. One or more layers of the nonwoven fabric may extend into the projections defined by the liquid-acceptance layer, as depicted in FIGURE 5. This arrangement desirably acts to channel and control the flow of liquid introduced into the nonwoven

fabric, and desirably minimizes the "land" areas of the fabric, which contact the skin of the wearer of a disposable absorbent article. The fluid management capabilities of the present nonwoven fabric can be further enhanced by providing the fabric with a plurality of apertures that preferably extend from the upper surface layer through at least a portion of the nonwoven fabric. Most preferably, these apertures extend from the network of channels that surround the upstanding projections. The apertures cooperate with the upstanding projections to channel and direct liquid into the apertures so that it can be directed into the associated liquid-retaining structure.

When the precursor web P is optionally provided with a third cellulosic fibrous layer, as described above, hydroentanglement of the precursor web results in formation of the present nonwoven fabric. While the liquid retention layer at least partially comprises cellulosic fibers selected from the group consisting of wood pulp fibers, rayon fibers, or blends thereof, the liquid-retention layer may further comprise a blend of such cellulosic fibers, and thermoplastic fibers having a denier between about 6 and 18 preferentially selected from the group consisting of polyolefins, polyesters, polyamides, and blends thereof.

Hydroentanglement of the liquid-retention layer can act to diminish void volumes within the layer that would be expected to reduce the liquid-retaining characteristics of the layer. However, the desired level of liquid-retention can be achieved by selecting fibers that exhibit inherent absorptivity (such as rayon fibers or profiled fibers). Additionally, the liquid-retention layer can be surface napped, at the outwardly facing surface thereof, for enhancing absorbent capacity. Ordinarily, such surface napping can diminish the structural integrity of an absorbent structure. However, because of the relatively high degree of structural integrity imparted to the liquid-retention layer by hydroentanglement in accordance with the present invention, surface napping of the retention layer does not unacceptably diminish its structural integrity.

With particular reference to FIGURES 2A-2C and 3A-3C, therein are illustrated various embodiments of the foraminous forming surface of the image

transfer device 18 upon which fabrics formed in accordance with the present invention are hydroentangled. FIGURE 2A illustrates a forming surface referred to as "smooth tacks", wherein the forming surface comprises an array of surface depressions which taper generally downwardly from an outside diameter of 0.34 inches to a lower, foraminous grid-like circular region having a diameter of 0.021 inches. FIGURE 2B illustrates a forming surface designated "8 wale", having a series of upstanding rails which are positioned above and intersect with a lower series of rails, whereby an array of surface depressions is defined. FIGURE 2C, showing a pattern designated as "dots", shows a forming surface including an array of depressions (light colored) each having a diameter of 0.14 inches, spaced 0.25 inches apart, with "nubs" (dark colored) extending upwardly from the forming surface for formation of apertures in a nonwoven fabric formed thereon.

FIGURE 3A shows a forming surface designated "multi-nub" including an array of surface depressions (light colored) each having a diameter of 0.156 inches and an array of aperture-forming projections (dark colored). FIGURE 3B illustrates a foraminous forming surface designated "double-hole bar", including an array of generally elongated surface depressions of two different sizes (light colored) and an array of circular, upstanding projections each having a diameter of 0.188 inches (dark colored) for formation of apertures in a nonwoven fabric hydroentangled thereon. FIGURE 3C illustrates a foraminous forming surface designated "diagonal bar" wherein an array of elongated surface depressions, each having a length of 0.625 inches, is arranged with an array of upstanding circular projections each having a diameter of 0.188 inches for formation of apertures in a nonwoven fabric formed thereon.

The surface depressions defined by the forming surfaces of the image transfer device used for practicing the present invention can be configured in accordance with the image profiles as shown in FIGURE 4. The profiles can be selected to optimize fluid management, particularly optimizing control and direction of liquid into the network of channels and associated apertures, which

surrounds the upstanding projections of the liquid-acceptance layer of the present nonwoven fabric.

In addition to formation of the liquid-retention layer of the present fabric from cellulosic fibers, it is further contemplated that this layer may comprise superabsorbent polymer for enhancing the absorbent capacity of the layer. Superabsorbent polymers are well known in the art, and frequently are employed in particulate form. However, these types of materials are also available in fiber form, and can be heat-activated after fabric formation so that the polymer exhibits the desired superabsorbency. By integration of such fibers into the cellulosic fibrous layer which forms the liquid-retention layer of the present fabric, the fibrous superabsorbent polymer can be heat-activated by drying cans 26 of an apparatus which is illustrated in FIGURE 1.

EXAMPLE 1

A multi-component fabric is formed with an apparatus such as illustrated in FIGURE 1 by forming a prebond web from carded webs, two of which were air-randomized, comprising 50% by weight 6.0 denier by 2.0 inch T-216 PET fibers, and 50% by weight 1.5 denier by 1.57 inch staple length Type 8192 rayon, available from Lenzing. The carded webs are integrated on a flat bed entangler 12 by subjecting the prebond web structure to fluid entanglement under 12 successive manifolds, three each operated at 100 psi, 300 psi, 600 psi, and 800 psi. Each manifold defines orifices of 0.005-inch diameter, with 43.3 orifices per inch. Line speed was 15 yards per minute, with the web subjected to drying at an elevated temperature by three drying cans each operated at 300° F.

Additional carded web of the same construction as above was layered onto the above-described prebond web, with the resultant precursor web hydroentangled on flat bed entangler 12 by twelve manifolds, three each operated at 100 psi, 300 psi, 600 psi, and 1000 psi.

The final fabric was formed by adding four carded webs, two of which were air-randomized, to the above-described prebond web, with each of these further card webs comprising 1.5 denier by 1.57 inch staple length Type 8192 rayon, with each of these cards being air-randomized. These four, carded webs

were layered onto the above-described prebond web, with the resultant precursor web hydroentangled on flat bed entangler 12 by twelve manifolds configured as described above and operated at 100 psi, 300 psi, 600 psi, and 1000 psi. This precursor web was then imaged and patterned on image transfer device 18 having a "smooth tacks" pattern as illustrated in FIGURE 2A, with three entangling manifolds 22 each operated at 4000 psi, with each manifold having an orifice strip having orifices of 0.005 inch diameter, with 43.3 orifices per inch. The fabric was dried at an elevated temperature by three drying cans operated at 300° F, with a formation line speed of 15 yards per minute, and a final fabric basis weight of 8.5 ounces per square yard. In the resultant multi-component fabric, the first fibrous layer of the precursor web consisted of all rayon fibers, and were positioned against the forming surface of the image transfer device to form the surface projections, as shown schematically in FIGURE 6. The combined cellulosic layers result in a fabric having a high degree of wickability, and to be particularly useful in the rapid relocation of fluid away from the imaged rayon surface.

EXAMPLE 2

A multi-component fabric was formed as described above in connection with Example 1, except that the additional carded web comprising 50% by weight 6.0 denier by 2.0 inch T-216 PET fibers, and 50% by weight 1.5 denier by 1.57 inch staple length Type 8192 rayon, available from Lenzing was not added to the prebond web and an image transfer device having a forming surface configured in accordance with the "8 wale" configuration illustrated in FIGURE 2B was employed, with three entangling manifolds 22 each operated at 2400 psi. The resultant multi-component fabric had a basis weight of 5.1ounces per square yard.

EXAMPLE 3

A multi-component fabric is formed with an apparatus such as illustrated in FIGURE 1 by forming prebond web from first and second carded webs each comprising air-randomized 6.0 denier by 2.0 inch T-216 PET fibers available from Wellman. Third and fourth carded webs are placed on the first two carded

webs, with each of the third and fourth webs comprising 40% by weight 6.0 denier by 2.0 inch T-216 PET fibers, and 60% by weight 1.5 denier by 1.57 inch staple length Type 8192 rayon, available from Lenzing.

The carded webs are integrated on a flat bed entangler 12 by subjecting the prebond web structure to fluid entanglement under 12 successive manifolds, three each operated at 100 psi, 300 psi, 600 psi, and 800 psi. Each manifold defines orifices of 0.005-inch diameter, with 43.3 orifices per inch. Line speed was 15 yards per minute, with the web subjected to drying at an elevated temperature by three drying cans each operated at 300° F. The final basis weight of the prebond was 3.2 ounces per square yard.

The final fabric was formed by adding two additional carded webs to the above-described prebond web; the first carded web comprising air-randomized 6.0 denier by 2.0 inch T-216 PET fiber, randomized and the total weight being 1.3 ounces per square yard, the second carded web comprising 3.0 denier by 2.0 inch T-502 splittable fiber (16 sub-denier, PET/nylon, 0.19 denier sub-denier, segmented pie, available from Fiber Innovation Technology, Inc.), with each of these cards being air-randomized and the total weight being 1.3 ounces per square yard. These carded webs were layered onto the above-described prebond web, with the resultant precursor web hydroentangled on flat bed entangler 12 by twelve manifolds configured and operated as described above. This precursor web was then imaged and patterned on image transfer device 18 having a "smooth tacks" pattern as illustrated in FIGURE 2A, with three entangling manifolds 22 each operated at 2850 psi, with each manifold having an orifice strip having orifices of 0.005 inch diameter, with 43.3 orifices per inch. The fabric was dried at an elevated temperature by three drying cans operated at 300° F, with a formation line speed of 15 yards per minute, and a final fabric basis weight of 6.2 ounces per square yard. In the resultant multi-component fabric, the splittable fibers provided the first fibrous layer of the precursor web, and were positioned against the forming surface of the image transfer device for formation of the liquid-acceptance layer. The two layers of PET fibers formed the second fibrous layer of the precursor web, and formed the

liquid-distribution layer of the resultant fabric. The PET/rayon fibers formed the third, cellulosic fibrous layer of the precursor web, and formed the liquid-retention layer of the resultant fabric.

EXAMPLE 4

A multi-component fabric was formed as described above in connection with Example 3, except that an image transfer device having a forming surface configured in accordance with the "dots" configuration illustrated in FIGURE 2C was employed. The resultant multi-component fabric had a basis weight of 6.2 ounces per square yard.

EXAMPLE 5

A prebond web was formed from four carded, air-randomized webs, two of which were air-randomized, each comprising 50% by weight 11.0 denier by 2.0 inch T-261 PET fibers from Wellman, and 50% by weight 1.5 denier by 1.57 inch staple Type 8191 from Lenzing. The webs were hydroentangled on the flat bed entangler 12 by twelve manifolds (0.005-inch orifices by 43.3 orifices per inch), with three each operated at 100 psi, 300 psi, 600 psi, and 600 psi. Three drying cans were operated at 300° F, with a line speed of 20 yards per minute. The resultant prebond web had a basis weight of 3.5 ounces per square yard.

The final nonwoven fabric embodying the present invention was formed by adding two additional carded webs, the first carded web comprising 6.0 denier by 2.0 inch T-216 PET fibers, and the second carded web comprising air-randomized 2.5 denier by 2.0 inch N-91 splittable fiber (20 sub-denier, segmented pie, PET/nylon, 0.12 denier sub-denier fibers from Unitika). These carded webs were layered onto the above-described prebond web, and hydroentangled therewith on the flat bed entangler 12 with orifice strips as described above, with three each of the twelve manifolds successively operated at 100 psi, 300 psi, 600 psi, and 1100 psi.

The precursor web was then positioned on the image transfer device 18, having the "smooth tacks" forming surface illustrated in FIGURE 2A. The precursor web was imaged and patterned by operation of three manifolds 22 at 2480 psi, with each manifold including 0.005-inch diameter orifices, 43.3

orifices per inch. The splittable fibers were positioned on the forming surface of the image transfer device, and provided the first fibrous layer of the precursor web. The 6 denier PET fibers provided the second fibrous layer of the precursor web, with the PET/rayon (large denier) fibers providing the third, cellulosic fibrous layer of the precursor web. The resultant nonwoven fabric, having liquid-acceptance, liquid-distribution, and liquid-retention layers, was dried at an elevated temperature by drying cans 26 operated at 300° F. (two cans), with a line speed of 10 yards per minute. Final fabric basis weight was 7.0 ounces per square yard.

EXAMPLE 6

A prebond web was formed from three carded webs, two of which were air-randomized, each comprising 50% by weight, 1.5 denier by 1.57 inch staple 8192 rayon, and 50% by weight, 1.5 denier by 1.57 inch staple 8191 rayon. The card webs were hydroentangled on flat bed entangler 12 with manifolds configured as described above, with three each of the manifolds operated at 50 psi, 300 psi, and 400 psi. The prebond web was dried on two drying cans operated at 300° F, with a line speed of 20 yards per minute, and a final basis weight of 2.0 ounces per square yard.

A second prebond web was formed from 3 carded webs, two of which were air-randomized, each comprising 3.0 denier by 1.5 inch staple 4DG fiber available from Fiber Innovation Technology, Inc., a profiled fiber configured in accordance with U.S. Patent No. 5,855,798 and 5,977,429, hereby incorporated by reference. The card webs were hydroentangled on flat bed entangler 12 with manifolds configured as described above, with three each of the manifolds operated at 50 psi, 300 psi, and 400 psi. The prebond web was dried on two drying cans operated at 300° F, with a line speed of 20 yards per minute, and a final basis weight of 1.5 ounces per square yard.

A third prebond web was formed from 3 carded webs, two of which were air-randomized, with each of the carded webs comprising 3.0 denier by 2.0 inch staple T-502 splittable fiber (16 sub-denier, PET/nylon, 0.19 denier sub-denier, segmented pie, from Fiber Innovation Technology, Inc.). The carded webs were

hydroentangled on the flat bed entangler, having manifolds as described above, with three each of the manifolds operated at 50 psi, 300 psi, 600 psi, and 800 psi. The web was positioned on a 100-mesh screen, and subjected to the action of water jets (three manifolds, 0.005 inch diameter orifices, 43.3 orifices per inch), operated at 2500 psi, to effect splitting of the splittable fibers. The prebond web was dried on two drying cans operated at 300° F, with a line speed of 20 yards per minute, and a final basis weight of 1.83 ounces per square yard.

The three prebond fabrics described above were layered in the following given above, and were pre-entangled on the flat bed entangler 12 as described above, with each of three manifolds operated at 50 psi, 300 psi, 600 psi, and 800 psi. This precursor web was then positioned on the image transfer device 18 having a forming surface of "dots" configured in accordance with FIGURE 2C, with each of the three manifolds 22 operated at 1600 psi. The splittable fibers were positioned adjacent the image transfer device, with the 3 denier 4DG PET fibers positioned in the next layer , and with the rayon fibers positioned in the next layer. The fabric was dried at an elevated temperature on three drying cans operated at 300° F, with the fabric formed at a line speed of 15 yards per minute. Final fabric basis weight was 6.05 ounces per square yard.

EXAMPLE 7

A material was formed as described in Example 6. Application of a teasel brush was employed to the rayon-containing side of the material until the material reached the bulk shown in Table 3.

EXAMPLE 8

A multi-component fabric is formed as described in Example 6 except the first prebond web was formed from four carded webs, two of which were air-randomized, each comprising 50% by weight 11.0 denier by 2.0 inch T-261 PET fibers from Wellman, and 50% by weight 1.5 denier by 1.57 inch rayon staple Type 8191 from Lenzing. The resultant prebond web had a basis weight of 3.5 ounces per square yard. The final fabric basis weight was 6.98 ounces per square yard.

EXAMPLE 9

A material was formed as described in Example 8. Application of a teasel brush was employed to the rayon-containing side of the material until the material reached the bulk shown in Table 3.

EXAMPLE 10

A multi-component fabric is formed as described in Example 6 except the first prebond web was formed from two carded webs each comprising air-randomized 6.0 denier by 2.0 inch T-216 PET fibers available from Wellman. Third and fourth carded webs are placed on the first two carded webs, with each of the third and fourth webs comprising 50% by weight 6.0 denier T-216 PET fibers, and 50% by weight 1.5 denier by 1.57 inch staple length Type 8192 rayon, available from Lenzing. The line speed was 15 yards per minute, with the web subjected to drying at an elevated temperature by three drying cans each operated at 300° F. The final basis weight of the prebond was 3.2 ounces per square yard. The final fabric basis weight was 6.67 ounces per square yard.

EXAMPLE 11

A material was formed as described in Example 10. Application of a teasel brush was employed to the rayon-containing side of the material until the material reached the bulk shown in Table 3.

Accompanying Tables 1, 2, and 3, set forth test data obtained in connection with testing of the above-described Examples. Testing was done in accordance with the following standard test methods.

Test	Method
Basis Weight (oz/sy)	ASTM D3776
Thickness (mils	ASTM D5729
Tensiles - MD and CD Grab (lb/in)	ASTM D5034
Elongation - MD and CD Grab (%)	ASTM D5034
Absorbency - Time (sec)	ASTM D1117
Absorbency - Capacity (%)	ASTM D1117
Strike Through (sec)	EDANA 150.3
Rewet (grams	EDANA 151.1

No Load Capacity (gr. Liquid / gr. Fabric): This test entails the following procedure. A 5 inch by 5 inch sample is weighed. Then it is submerged into a saline solution (0.9%) for 15 minutes. The sample is removed from the solution and allowed to drain vertically for one minute. The sample is then weighed again. The no load capacity is reported as the ratio of the fabric weight after submersion to the weight of fabric before submersion.

For comparison purposes, a disposable "swimmer" absorbent product (i.e., a disposable absorbent swimwear article) was tested, with results as shown. As will be observed from the test data, fabrics formed in accordance with the present invention provided excellent absorbent characteristics, particularly by comparison of the absorbency of the fabrics (as a percentage of fabric weight), relative to the thickness of the fabrics. Additionally, fabrics formed in accordance with the present invention exhibited excellent structural integrity especially compared to the disposable "swimmer" absorbent product, thus facilitating their efficient use in high-speed manufacture of disposable absorbent products.

Exemplary disposable absorbent articles which can be configured in accordance with the present invention include disposable diapers, disposable training pants and "swimmers", sanitary protection products, adult incontinent products, incontinence pads, and like disposable absorbent structures. U.S. Patents No. 4,695,278, to Lawson, and No. 4,704,116, to Enloe, both hereby incorporated by reference, illustrate exemplary disposable diapers. U.S. Patents No. 4,938,753, No. 4,938,757, and No. 4,940,464, all to Van Gompel, all hereby incorporated by reference, illustrate exemplary disposable training pants. U.S. Patents No. 4,589,876, and No. 4,687,478, both to Van Tilburg, and both hereby incorporated by reference, illustrate exemplary sanitary napkin constructions.

From the foregoing, numerous modifications and variations can be effected without departing from the true spirit and scope of the novel concept of the present invention. It is to be understood that no limitation with respect to the specific embodiments disclosed herein is intended or should be inferred. The

disclosure is intended to cover, by the appended claims, all such modifications as fall within the scope of the claims.

TABLE 1

		Example 1		Example 2	
	"Target"	Face Up	Face Down	Face Up	Face Down
TEST					
Fiber Composition	Consumer Product	Rayon Face 50% PET 50%Rayon Back		Rayon Face 50% PET 50%Rayon Back	
Image		Tacks		8 Wales	
Basis Weight (oz/sy)	10.45	8.5		6.3	
Thickness (mils)	1457.5	90		60	
Tensiles - MD Grab (lb/in)	2.2	113.85		65.79	
Tensiles - CD Grab (lb/in)		44.8		30.86	
Elongation - MD Grab (%)	21.67	43.29		47.37	
Elongation - CD Grab (%)		101.96		87.9	
Absorbency - Time (sec)	7	1.1		1.2	
Absorbency - Capacity (%)	1082	609		710	
No Load Capacity (gr. Liquid / gr. Fabric)	9.25	6.25		5.95	
Strike Through (sec)	1.45	0.28	0.57	0.69	0.88
Rewet (grams)	2.74	3.53	3.23	3.61	3.37

TABLE 2.

		Example 3	Example 4	Example 5
	"Target"	Face Up	Face Up	Face Up
TEST				
Fiber Composition	Consumer Product	Splittable Face 6dpf PET 6dpf - Rayon Back	Splittable Face 6dpf PET 6dpf - Rayon Back	Splittable Face 6dpf PET 11 dpf PET/ Rayon Back
Image		Tacks	Dots	Dots
Basis Weight (oz/sy)	10.45	6.2	6.24	7.04
Thickness (mils)	1457.5	64.5	71	85
Tensiles - MD Grab (lb/in)	2.2	109.77	118.72	106.61
Tensiles - CD Grab (lb/in)		54.15	57.46	62.23
Elongation - MD Grab (%)	21.67	55.09	53.08	56.72
Elongation - CD Grab (%)		117.45	102.33	87.7
Absorbency - Time (sec)	7	2.9	4	2
Absorbency - Capacity (%)	1082	549	516	617
No Load Capacity (gr. Liquid / gr. Fabric)	9.25	4.35	4.37	4.72
Strike Through (sec)	1.45	0.98	0.81	0.52
Rewet (grams)	2.74	3.64	3.65	2.51

TABLE 3

	Example 6	Example 7	Example 8	Example 9	Example 10	Example 11
		Hand Napped Back Side		Hand Napped Back Side		Hand Napped Back Side
TEST						
Fiber Composition Face	Splittable 4DG PET Rayon	Splittable 4DG PET Rayon	Splittable 4DG PET 11 dpf PET/ Rayon	Splittable 4DG PET 11 dpf PET/ Rayon	Splittable 4DG PET 6 dpf PET/ Rayon 6 dpf PET	Splittable 4DG PET 6 dpf PET/ Rayon 6 dpf PET
Image	Dots	Dots	Dots	Dots	Dots	Dots
Basis Weight (oz/sy)	6.05	6.35	6.98	6.91	6.67	6.72
Thickness (mils)	63	85	61	93	81	104
Tensiles - MD Grab (lb/in)	41.8	37.19	58.7	44.58	40.98	40.69
Elongation - MD Grab (%)	26.29	34.05	33.57	29.82	35.75	37.8
Absorbency - Time (sec)	3	8	1.5	4.5	20	30
Absorbency - Capacity (%)	751	963	607	899	911	1158